AUTOMATED GUIDED VEHICLE (AGV)
USING 68HC11 MICROCONTROLLER

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This thesis is submitted as partial fulfillment of the requirements for the award of the Bachelor Degree of Electrical Engineering (Electronics)

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APRIL, 2006

ABSTRACT

Nowadays the creations of Automated Guided Vehicle (AGV) model can be found from all over the countries, as it give many advantages in our lives. It works just like a robot as it is able to sense and response to the environment. Considering that, AGVs should be well developed to optimize it's benefits to our own living. The aim of this project is to build a prototype of an Automated Guided Vehicle (AGV) model that can move on a flat surface with its two driving wheels and a free wheel. The prototype is able to follow line on floor with the M68HC11 microcontroller as it main brain that control all the navigation and responses to the environment. The ability to follow line on floor is an advantage of this prototype as it can be further developed to do more complicated task in real life. To follow the line, the microcontroller is attached to a sensor that continuously reflecting to the surface condition. Therefore, this project involves of designing and fabrication of the hardware and circuitry. The key study in this project is the algorithm designed in assembly language, embedded in the microcontroller.

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CHAPTER 1

INTRODUCTION

This chapter will discuss on the term AGVs. What is AGVs? Some brief history of AGVs and background are discussed. The problem statement stated the reasons to the creation and development of AGVs around the world. The objective and scope of this project is also presented in this chapter.

1.1 AGVs

There are many definitions of AGVs, different according to points of view.

Wikipedia, the free encyclopedia, defines AGVs as:

“A robot that been used highly in industrial applications to move materials from point to point”

The American Society of Safety Engineers (ASSE) defined AGVs as:

a. Machines without drivers that can move along pre-programmed routes, or use sensory and navigation devices to find their own way around.
b. Vehicles that are equipped with automatic guidance systems and are capable of following prescribed paths.
c. Driverless vehicles that are programmed to follow a guide path.

1.2 Background

The creations of Automated Guided Vehicle (AGV) have been around since the 1950's and the technology was first developed by Barret Electronics from Grand Rapids, Michigan. It was then developed by the Europeans in the 1970's and nowadays AGVs can be found in any countries. One of the first AGVs was a towing vehicle that pulled a series of trailers between two points, and today's there are many task given to AGVs and they also have their own name and potentials.

Considering the full potentials and advantages of the Automated Guided Vehicle (AGV) in our livings, it is valuable to do this project, as it also will be the first step towards the creation of more intelligent technology or system. The simplest AGV model may use just a sensor to provide its navigation and can be the complex one with more sensors and advance systems to do the task. They can work or do the task everywhere needed but the safety for the AGV as well as the people and environment surround it must be provided.

The AGVs is just the same as mobile robot, which can moves from one place to another to do their task, but mostly the mobile robot is used for difficult task with dangerous environment such as bomb defusing. Furthermore, the mobile robot can be categorized into wheeled, tracked, or legged robot. Although the AGVs may not be glamorous of robots, but their work, which usually menial, are often be essential to the smooth running of factories, offices, hospitals, and even houses. They can work without any complaint around many workplaces all over the world.

1.3 Problem statement

There are many reasons which yield to the creation of Automated Guided Vehicle (AGV) around the world. Mostly the reason is to overcome the logistic problems that often occurred in the workplaces and to make improvement to the facilities provided in the workplaces. Usually the AGVs are implemented in factories, hospitals, offices, houses, and even can be found anywhere outdoors without the people surround realized it.

In the industries or factories, the AGVs can ease the physical strain on human workers by performing tiring tasks, such as lifting and carrying heavy materials, more efficiently with no signs of fatigue creeping in. They can carry far more than human workers, and their movements can be tracked electronically at all times. Their movements can be timed to feed or collect products or materials from the workcells in the factories.

Besides that, in the hospitals thousands of staff spends a portion of their day moving medical supplies, bedding, medicines and other equipment around large hospitals. By using the AGVs, the strain on the workers can be ease as well as the hospital's system would be more smart and systematic without any bad complaint from the patients and people. AGVs also capable of both cutting cost and releasing more staff hours to tend and care for patients.

Therefore it is very significant that the valuable knowledge on AGV construction is studied and be further implemented from the result of this project. It is due to its advantages to our own living and technology.

1.4 Objective and Scope of The Project

The objective and scope of this project is to create an AGV model that can follow a trail of line on a flat surface horizontally. This AGV model is using M68HC11 microcontroller to control all navigation during its operation. In other words, the microcontroller acts just like the brain for the model that controls all operation of the system.

The model is a three-wheeled mobile robot that has the ability to follow line on floor. There are three wheels including two driving wheels controlled by two motors and a free wheel in front that is able to rotate 360˚. With three wheels, both driving wheels are always in contact with the surface, because of the robot's steering relies on both its driven wheels being in contact with the surface at all times.

This project consists of four main stages, which are theoretical design, mechanical fabrication, electronic hardware design and as well as algorithm design in assembly language. The matter to be considered is how the robot can follow the trail of line continuously. It is also important to choose the most suitable microcontroller, actuators, and sensors to achieve the project objectives.

CHAPTER 2

LITERATURE REVIEW

2.1 Automated Guided Vehicle Built worldwide

Some of the Automated Guided Vehicles (AGVs) that are well known are discussed in brief.

2.1.1 Mobile Post Distribution system (MOPS)

MoPS or Mobile Post Distribution System (Tschichold, Vestli, Schweitzer, 1999) is a research AGV developed at the Institute of Robotics in Zurich, Switzerland. It is used to transport mail around the Swiss Federal Institute of Technology in Zurich. MoPS is powered up by rechargeable batteries which give it a 4-hour active life, weighs around 90kg and can carry up to 50 kg of postal payload. It is also capable of hot-swapping its own batteries pack, thus ensuring 24h availability.

The MOPS provide services of picking up boxes with incoming mail at the ground floor of the five floor building, which is sorted by human first, delivering them to the secretaries' offices, subsequently bringing back the outgoing mail to the ground floor station. It is also capable of switching floors by sending an infrared signal to the building’s lifts. As the building is open to the public, protection against theft of the mail is provided by motorized blinds over the pigeon-hole mail points, which can be opened by the robot and by authorized staff.

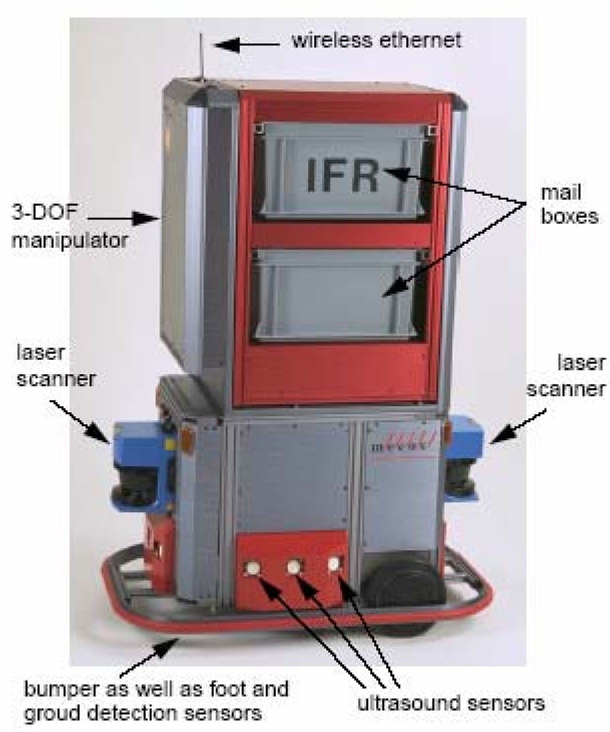

Figure 2.1 The Mobile Post System MOPS. The upper part of the system constitutes a 3-DOF manipulator / storage mechanism for two mail boxes. The lower part is a mobile robot platform with two drive and one castor wheels.

MOPS navigation is based on the recognition of natural landmarks which are compared to data of the building layout stored on the robots processor. The system has a highly accurate localization and position control system, which enables MOPS to dock onto the pigeon holes and to load/unload boxes of mail. A hybrid navigation scheme combining graph-searching with a situation based behavior selector and appropriate behaviors is used. The generated paths are close to being optimal, and the tolerance towards obstacles is high.

The interaction with humans takes place on various levels. The robot can be addressed by the secretaries and the maintenance offices by wireless internet communication, giving the robot its mail orders. The robot is supervised from the maintenance office, dealing with exceptional situations. Locally, service personnel can interact with the robot, having direct access to various robot functions.

The mobile robot has a distinctly visible status display, and humans crossing its way can interact with the machine which has to react to human given signals. The software is based on the object oriented real-time framework XOberon, fulfilling real-time requirements, and running on a PowerPC.

2.1.2 ParkShuttle AGVs of Amsterdam's Schiphol Airport

Figure 2.2 The ParkShuttle AGVs of Amsterdam's Schiphol Airport.

The ParkShuttle (FROG Navigation Systems) is an automatic navigating vehicle which provides transportation for passengers. It is a people mover system. There is no driver onboard, instead a computer and an electronic navigation system do the driving. This ParkShuttle has a safety system of sensitive and intelligent sensors. The sensors scan the area in front of the vehicle and will decelerate or stop the vehicle when an unknown obstacle is detected.

An additional safety feature is provided by the bumper system that brings the vehicle to an immediate halt when it is impressed. In addition, the vehicle has emergency stop buttons (both inside and outside) that can be operated by the passengers. The speed is limited to 40 km/h obtain a good ride quality.

The ParkShuttle vehicle runs on four rubber tires. Traction is provided by an electric motor powered by a rechargeable battery. Up to 100 km can be covered on one battery-load. It has a capacity of 10 passengers, 6 seated and 4 standees. It is easy to get into and out of the vehicle (wheelchair accessible) and provides good all-round visibility. Inside the vehicle is a console on which the passengers can indicate their destination.

Each vehicle is also fitted with an information display that announces the stop at which the vehicle has arrived. The maximum load is 800 kg. The maximum vehicle weight is monitored by means of weight sensor.

As soon as the total weight of the passengers and cargo exceeds the limit, the vehicle will refuse to depart and a message will automatically be announced. Sensors fitted in the doorways monitor the entrance and exit of passengers. The vehicle will never depart while a passenger is in the process of boarding and exiting.

People mover systems are often using some form of mechanical guidance, and these systems are already operating in different locations around the world. Vice versa this ParkShuttle is operating without mechanical guidance as it will find its way automatically traveling on a simple asphalt track with electronically guidance.

The main characteristics of this transportation system are small transportation units, high frequency, high density work, automatic operation, on-demand operation and simple infrastructure on ground level.

2.2 Applications of Mobile Robots

There are so many mobile robots can be seen around the countries over the world. Furthermore the applications of mobile robots can be seen in many fields. Mobile robots applications include in various fields (Alonzo Kelly, 1996) as listed in the Table 2.1.

Table 2.1 Applications of Mobile Robots

Application	**Details**
Medical service	a. Deliver food, water, newspapers, and linens. b. Medication, administrative reports hazardous material, biological waste.
Commercial cleaning	a. Airports, supermarkets, malls, and factories. b. Lots of floor treatments like wash, sweep, mop, scrub, buff, wax, polish, vacuum, strip, shampoo, trash pick-up. c. Other unpleasant jobs like washing bathrooms, windows, upholstery.
Hazardous and energy	a. Bomb and mine mapping, retrieval and disposal. b. Nuclear plant inspection, steam generators. c. Hazardous waste storage tank inspection. d. Pipeline inspection crawlers. e. High tension power line inspection.
Space	a. Terrestrial inspections of space vehicles. b. Satellite on-orbit inspection. c. Planetary exploration.
Undersea	a. Drilling platform inspection. b.Translantic cable installation and maintenance. c. Exploration.
Material Handling	a. AGVs operate successfully today in highly structured automotive. and electronics factories. b. Loading and unloading of trucks, trains, ships, and planes.
Civil Transport	a. Aircraft inspection. b. Automated and/or intelligent highway vehicles.
Personal	a. Assistants for handicapped and elderly individuals. b. Assist with personal hygiene, working at home, recreation. c. Seeing Eye robot, smart self-navigating wheelchair.

2.3 Line Following Robot

Line following robot is generally a wheeled mobile robot. The method of line following varied depending on the number of sensors available and the type of line to be followed. There are four methods identified including edge following, line search, line trap, and cross-over. These four methods are different in number of sensors that used and also the results that will be obtained are different. With only one light sensor, the robot will have to know where the line is, or spends time searching to find it. Whereas with two light sensors, the robot is possible to remember which direction the line went. With more sensors, the result that will be obtained would be more excellent and the robot will be more intelligent. The line following method can be listed in Table 2.2 below.

Table 2.2 Line Following Method

Method	**Characteristic**
Edge following	Stay on the edge of the line
Line search	Stay on the line
Line trap	Keep the line between sensors
Cross-over	Move back and forth over the line

For each method, there are different characteristics and give choices to the builder of the line following robot to use which one from the list. The choice is depend on the function of the robot to be build as each method has its own advantages and disadvantages.

There are many line following robot have been built worldwide. Some of them will be discussed in brief.

2.3.1 Kerwin’s Line Following Robot

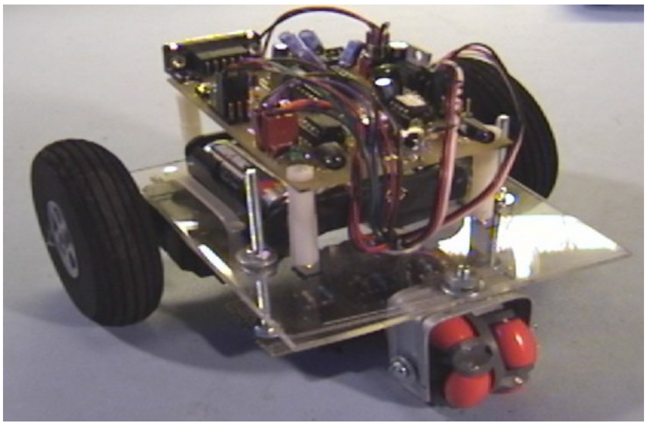

Figure 2.3 The Kerwin’s line following robot using three matched IR transmit/receive pairs.

The Kerwin’s line following robot (ranchbots) is a design with Futaba S-148 servo motors mounted to the bottom of the plexiglass. It has three wheels with the front wheel is the omni-directional wheel. The sensor system consists of an array of three matched IR transmit/receive pairs mounted on a circuit board that can be raised or lowered to fine tune the sensitivity. It uses the Atmel microcontroller as the controller part. The microcontroller takes input from sensor array and drives the servo motors in response.

2.3.2 Sandwich, The Line Following Robot

Figure 2.4 Sandwich, the small and uncomplicated line following robot.

Sandwich, the line following robot (Robot Room) is designed with smaller and lighter body, motors, connectors, and comparator as the brain. It does not use the microcontroller, thus no programming are developed. It uses two pairs of cadmium-sulfide photoresistors as the sensors instead of IR LEDs.

Sandwich is able to follow either light or dark paths, although the driving isn’t as smooth and can’t take as sharp of turns. It won’t stop when the path ends, and can’t automatically detect if the line is light or dark, thus manually detect the line using switch.

CHAPTER 3

ITEM SELECTIONS

In developing this expected prototype, it is important to choose the best materials or parts and components by considering the factors that contribute to determine the correct materials. The factors are such as the environment in which this prototype works, the reliability, cost effective, and any other factors that influence in which material choice is the correct one. By choosing and using the wrong components will lead to much more problems to the project's development, causing damage to the other parts and also escalating cost. Generally, the components and parts for building a robot is costly and therefore avoiding of wrong pick up materials is a suggestion to all the robot builder beginners.

3.1 Real Robots

In this project, it is decided to use the mechanical parts from the Real Robots. The components are good enough, reliable, and cost effective as compared to other components choices. For this project, it is not all of the Real Robot's part been used, as just the issues 1, 2, 3, 4, 11 and 12 of the Real Robots Magazines are ordered and the component for each issues are listed in Tables below.

Table 3.1 Components and parts from Issue 1

Issue 1
a. Chassis. b. Gear housing (base section x 2, middle section x 2, and top section x 2). c. 4 short self-tapping screws (to fix base section to chassis). d. 4 long screws (to fix housings together). e. 2 tyres (for rear wheels). f. 2 wheel hubs with pre-assembled axle and gear. g. 4 x spur gears. h. 4 x gear shafts.

Figure 3.1 Chassis

Figure 3.2 tyres

Figure 3.3 Gear housing top section

Figure 3.4 Gear housing base section

Figure 3.5 Gear housing middle section

Figure 3.6 wheel hubs with pre-assembled axle and gear